APPENDIX B

AVAILABLE AIR FORCE DATA

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B.1. INTRODUCTION

This effort to re-evaluate possible doses to those who responded to the Palomares nuclear accident required a complete and careful review and assessment of available data. Since the accident occurred over 33 years ago, this review depended on the ability to identify relevant records, reports and other data to form as complete a picture of the situation as possible. Initial efforts focused on accumulating and reviewing records provided by the Air Force Medical Operations Agency (AFMOA) at Bolling AFB, DC and the Institute for Environmental, Safety, And Occupational Health Risk Analysis (IERA) at Brooks AFB, TX. IERA succeeded the USAF Radiological Health Laboratory (RHL) as the Air Force's primary radiological consultant laboratory and custodian of personnel radiation exposure records in the USAF Master Radiation Exposure Registry. Initial contact with both AFMOA and IERA identified and provided information on the availability of Palomares records. IERA and AFMOA provided their records in the form of:

- Air Force Forms with laboratory analytical and exposure details of the nasal swipe and urine samples submitted and processed.
- Complete case files for the 26 individuals identified for follow-up in 1966 and commonly referred to as the "High 26".
- A Microsoft Excel spreadsheet prepared by IERA staff that contained the data from those Air Force Forms, and some data related specifically to the 26 individuals (referred to as the "High 26" who were considered as having the highest exposures.
- Copies of reports of the accident response, RHL documents on the evaluation of exposures by urinalysis, and selected publications from journals and conference proceedings.

Those records formed the basis for significant effort: to understand what information the various records contained; to determine how the data were used in the initial evaluations; to identify data gaps, inconsistencies, and concerns with the use or interpretation of the data; and to prepare the records for input to this intake and dose assessment effort. This appendix discusses the results of this review and the modifications and assumptions made to the data for use in the dose assessment. The appendix provides specific details of the three types of records and the concerns they generated, as well as efforts to correct, improve, or interpret those records for this project.

B.2. TYPES OF RECORDS KEPT

The records prepared and maintained by the Air Force consisted of forms, computer spreadsheets, and written correspondence and reports of activities. This section provides details of the forms and the data they contained.

B.2.1. Forms

RHL, as the central laboratory for providing radiological services to Air Force units, applied their laboratory processes with some modifications to this accident. RHL, a sub-unit of the Air Force Logistics Command (AFLC) at the time, used AFLC sanctioned forms for recording the data and results of samples processed. Three series of forms were identified in the records provided: AFLC Form 1165, Internal Dosimetry Data (May 66), AFLC Form 1165, Radiological Sample Data (May 66), and AFLC Form 1165, Radiological Sample Data (Jul 67). Although similar in design and content, these three forms apparently evolved over the course of the laboratory effort on Palomares and other services at the time.

B.2.1.1 AFLC Form 1165, Internal Dose Data (May 66)

The AFLC Form 1165, Internal Dose Data contained data about the individual who submitted the sample, radiation measurement data for urine, radon (breath) (sic), and feces/blood samples. The form provides areas for recording counting data, instrument data, and other factors. For Palomares, the form primarily recorded urine sample data and results. Figure B-1 illustrates an example AFLC Form 1165.

Annotated comments (callout boxes) on Figure B-1 draw attention to several features of the form and its use for the Palomares Accident. In addition to basic identifying information (name, and Social Security Number (SSN)), the form typically contained an entry for the Air Force Serial Number (AFSN) as an additional entry. At the time, the SSN had not become an official identifier for Air Force military personnel.

Comments about certain uses of the form pertain to the review and analysis of data contained on these forms for possible use in the reassessment project. These include (identified by text in callout box on Figure B-1):

- **Basic Counting Data**: this area provides spaces for the entry of Counter Identification (N), Counter Background (cpm), Counter Efficiency (%), and other pertinent counting information. Additional data were often recorded in this area. For example, the entry for Counter background - 0.03 (900) – refers to the counts per minute (0.03) and the time the background was counted (900 minutes).
- **Notation of Elapsed Days**: this entry – t = 49 – refers to the elapsed time (in days) between the assumed exposure and the date the sample was collected. According to other records, the exposure date was generally assumed to occur on the day that was the midpoint of an individual's time on station.
- **Exposure Date Entry**: an entry with the known or estimated dates of exposure. Often this represented the actual calendar time at the site performing duties. In this case, the entry contains a range of dates.

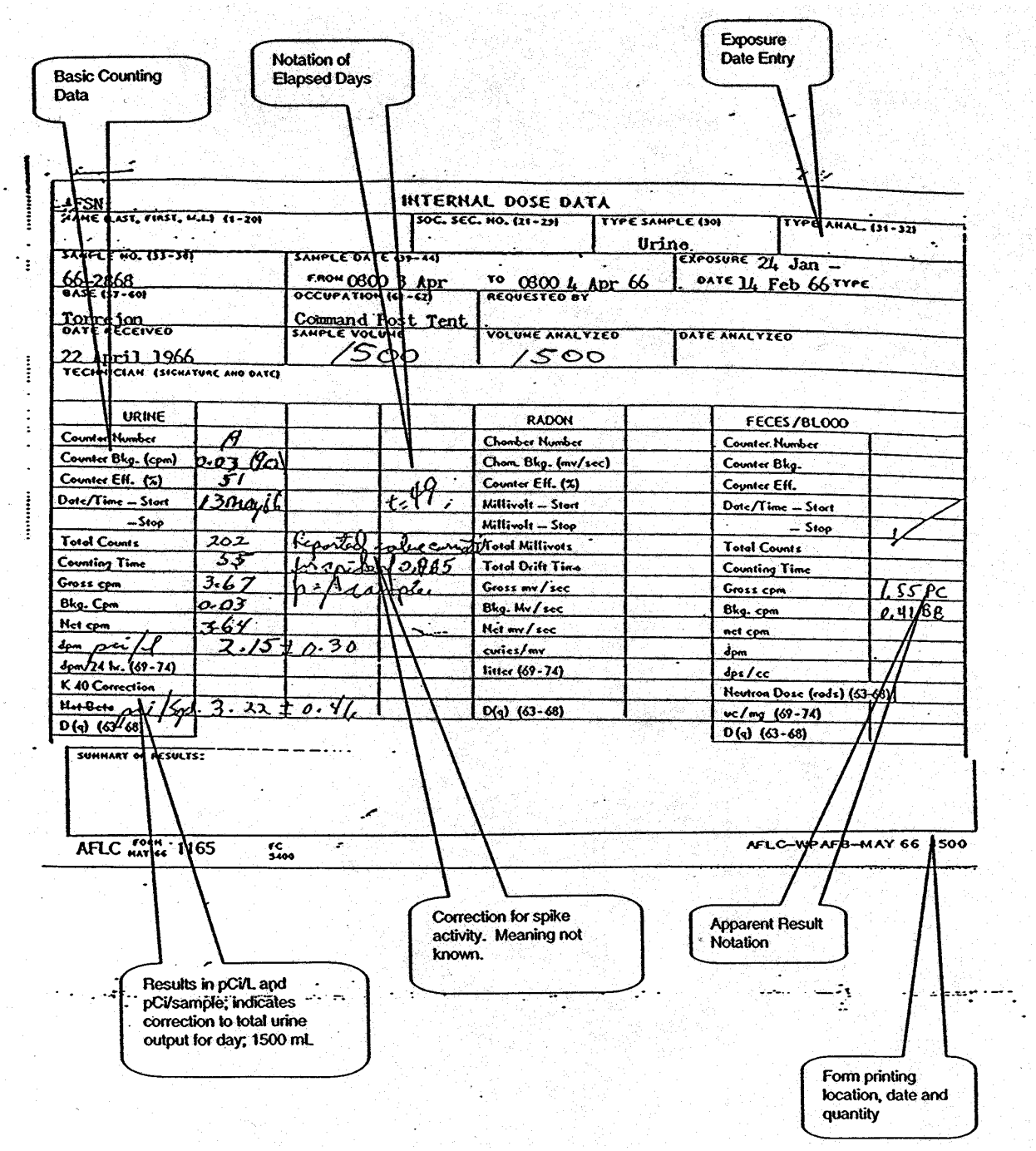

Figure B- 1. AFLC Form 1165, Internal Dose Data (May 66)

- **Results, etc.**: this section demonstrates flexibility in use of the form by hand written notations of the meaningful result. In this example, the result (2.15 ± 0.30 pCi/L) is expressed in activity per unit volume as picocuries per liter (pCi/L) and as activity per sample (pCi/spl). In this case, the pCi/spl means the total gross alpha activity excreted in one day as required by equations relating content in urine to systemic body content. In addition to the actual value, the estimated error (based on 95% confidence level of the counting data only) is also shown.
- **Correction for spike activity**: This notation apparently refers to a factor applied to correct for added ^{236}Pu radioactivity. The exact meaning of this notation has not been determined for gross alpha measurements.
- **Apparent Result Notation**: an entry in the feces/blood section that apparently represents an independent evaluation of the radioactivity content and an estimate of the fractional systemic body burden (0.44 BB).
- **Form printing location, etc.**: represents the place (WPAFB – Wright-Patterson Air Force Base), date (May 66), and quantity of forms printed (4500). This is an administrative requirement.

Figure B-2 provides a second example of an AFLC Form 1165, Internal Dose Data. For this case, three features are discussed.

- **Background counts, etc.**: this form clearly shows the entry of the counter background rate and counting time.
- **Exposure Date Entry**: this form contains one date rather than a range. Based on personal conversations with the individual, he arrived at the accident site early on 18 Jan 66 so the date of 19 Jan 66 is reasonable. Also, the individual said that he stayed at the site until close to the end of the operation. Therefore, a sample date of 18 Mar 66 could represent his last sample while on site. In fact that is the case.
- **Apparent Result Notation**: this entry refers to written notation ($D_R = 6.59 \times 10^{-3}$ μc). The notation D_R is identical to the notation for retained body burden in Langham's excretion equation for plutonium. That entry apparently denotes a retained body burden of 0.00659 microcuries or about 15%.

The previous examples provide the basis for further investigating the relevance of the data on these forms. The relevance may be particularly crucial because these forms represent data for some of the earliest samples collected; especially those collected on site at Camp Wilson that had a very high potential for sample container contamination as referred to by Odland (Odland 1968a and Odland 1968).

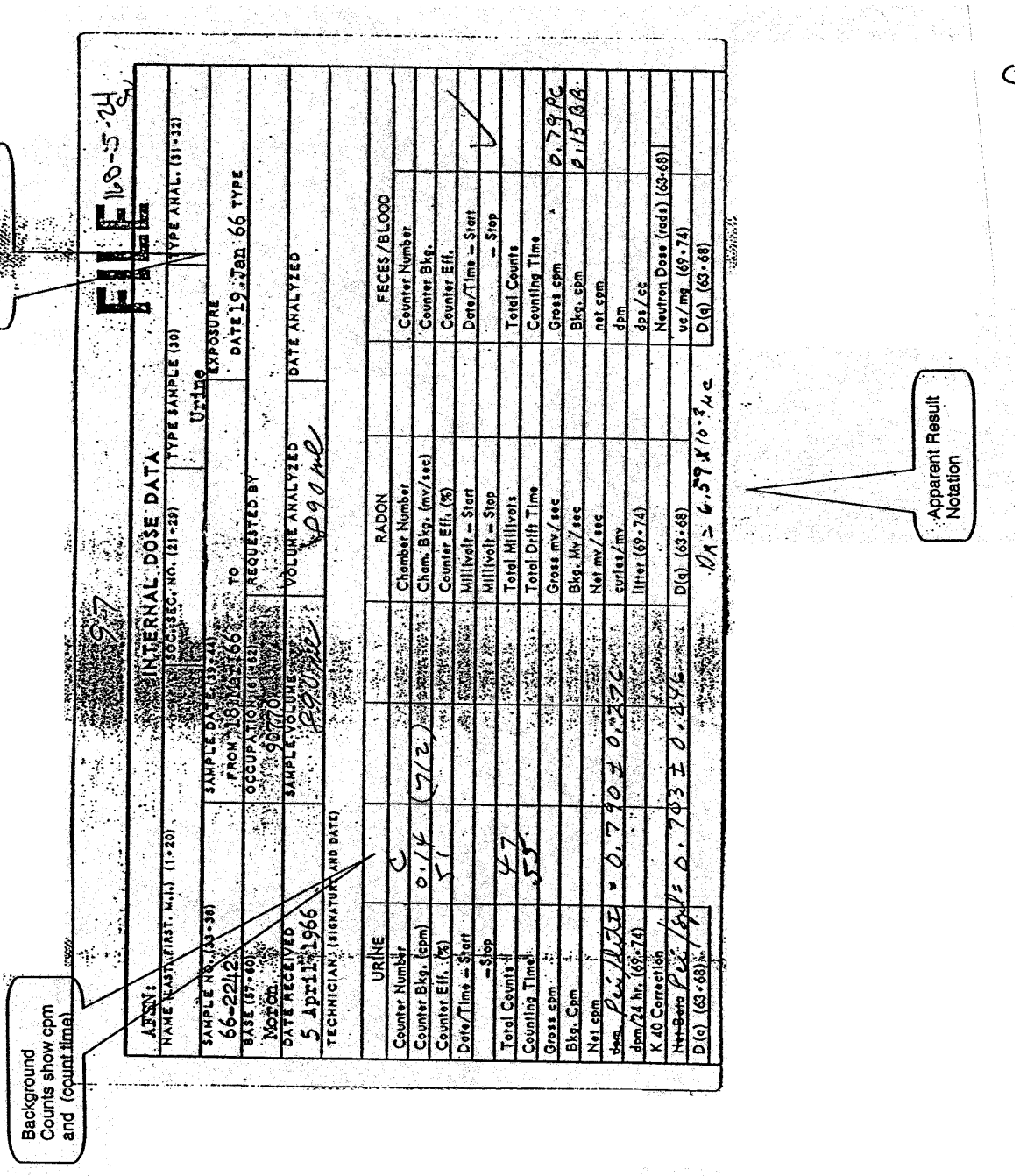

Figure B- 2. Another Example AFLC Form 1165, Internal Dose Data (May 66)

B.2.1.2 AFLC Form 1165, Radiological Sample Data (May 66)

The AFLC Form 1165, Radiological Sample Data (May 66) was apparently also used during the same time period as the previous form. However, our review indicates that this form applied primarily to samples analyzed by alpha spectrometry. Figure B-3 provides an example of this form and contains notations on several interesting features. These features include:

- **Alpha Spectrometry Counting Information:** This section of the form provides room for recording specific information about the radioactivity counting process. Entries include: identification of the radionuclide (^{236}Pu and ^{239}Pu) in separate columns; counter and efficiency (SPEC 2, 24.3); total counts and minutes for each (400, 571, 1 are the time, and the counts in the ^{236}Pu and the counts in the ^{239}Pu); background counts and time (800, 1, 1 as time, counts in the ^{236}Pu area and counts in the ^{239}Pu area). These entries are self-explanatory for the most part.
- **Elapsed Time in Days:** the time from exposure (assumed as midpoint of time at the accident site) to sample collection.
- **Exposure Time Entry:** An entry of the presumed exposure period. This example contains only the entry "66", presumably indicating the year 1966. No day or month information is entered.
- **Calculated Result:** the results of calculating the radioactivity. In this case entered as (Fci/Spl 4.5 ± 10.0) indicating 4.5 femtocuries per sample with an estimated counting error of 10.0 femtocuries per sample. Other evaluations indicate that for alpha spectrometry RHL calculated and reported the estimated error at the 68% confidence level. In this example, the error is greater than the calculated result.
- **Reported Results:** the result formally reported for this analysis. In this case the result was reported as No Detectable Activity (NDA) meaning that the sample result was less than the estimated error.

Observations about other data on this example reveal details of the processes used in analyzing samples. For instance, the Sample Volume (2000 mL) and the Volume Analyzed (1000 mL) indicate the standard practice that used one-half a submitted sample's volume thereby retaining a portion for further confirmation or reanalysis if laboratory difficulties were encountered.

B.2.1.3 AFLC Form 1165, Radiological Sample Data (Jul 67)

This data form represents an evolution of the previous two versions of the AFLC Form 1165. However, the form retains the same essential data presented on a piece of letter sized (8-1/2" × 11") card stock. This revised form retains the identifying information, but expands on and reformats the basic radioactivity counting and results information. Figure B-4 provides and example of this version of the form. Interesting features on the form are noted as before and include:

- **Gross Alpha Information:** this section contains the same information about the alpha counter data. In this case, total counts and time appear to be reversed; i.e. for TOTAL CTS AND TIME, the entries are 55 and 155. The first (55) was the RHL standard time for

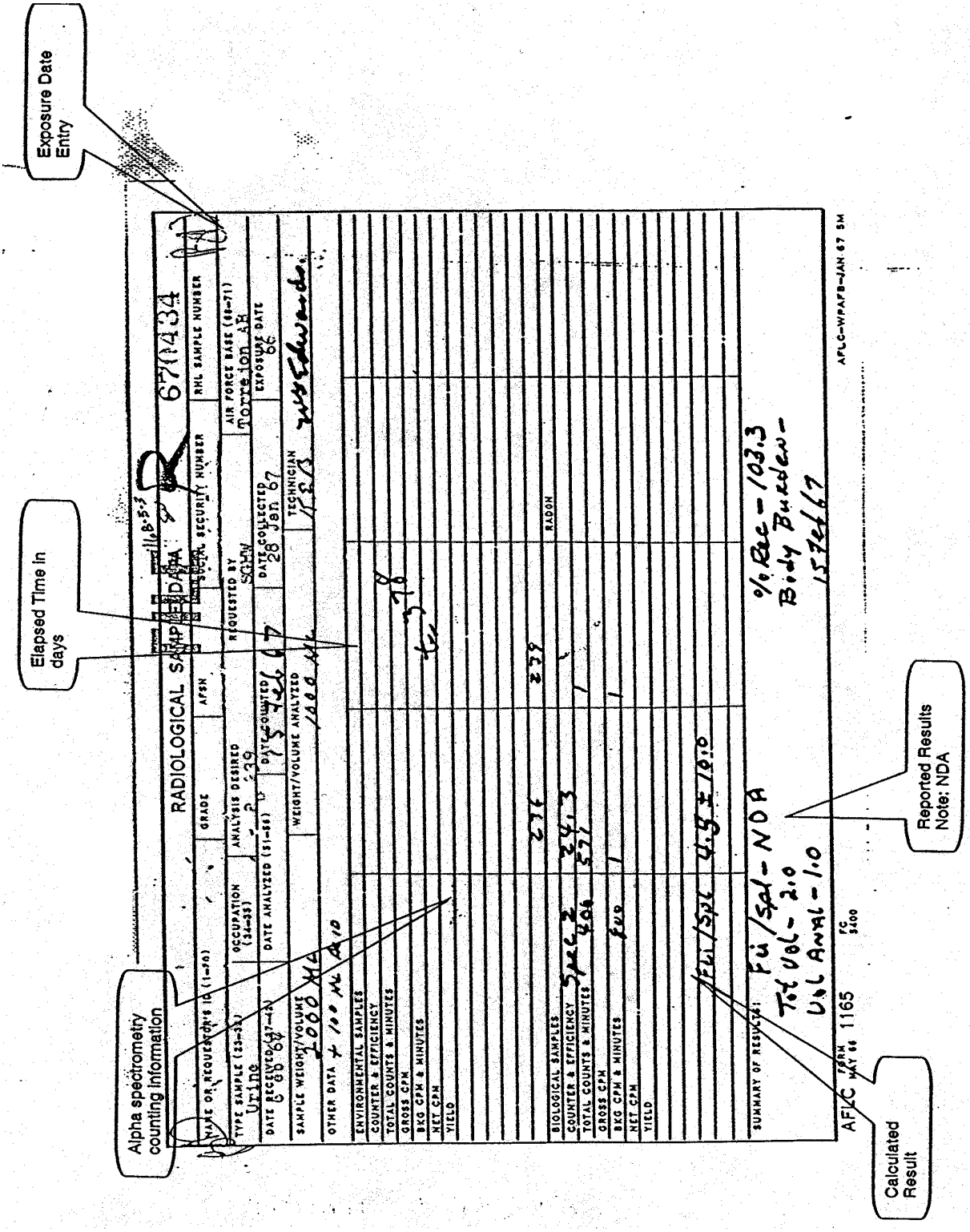

Figure B- 3. AFLC Form 1165, Radiological Sample Data (May 66)

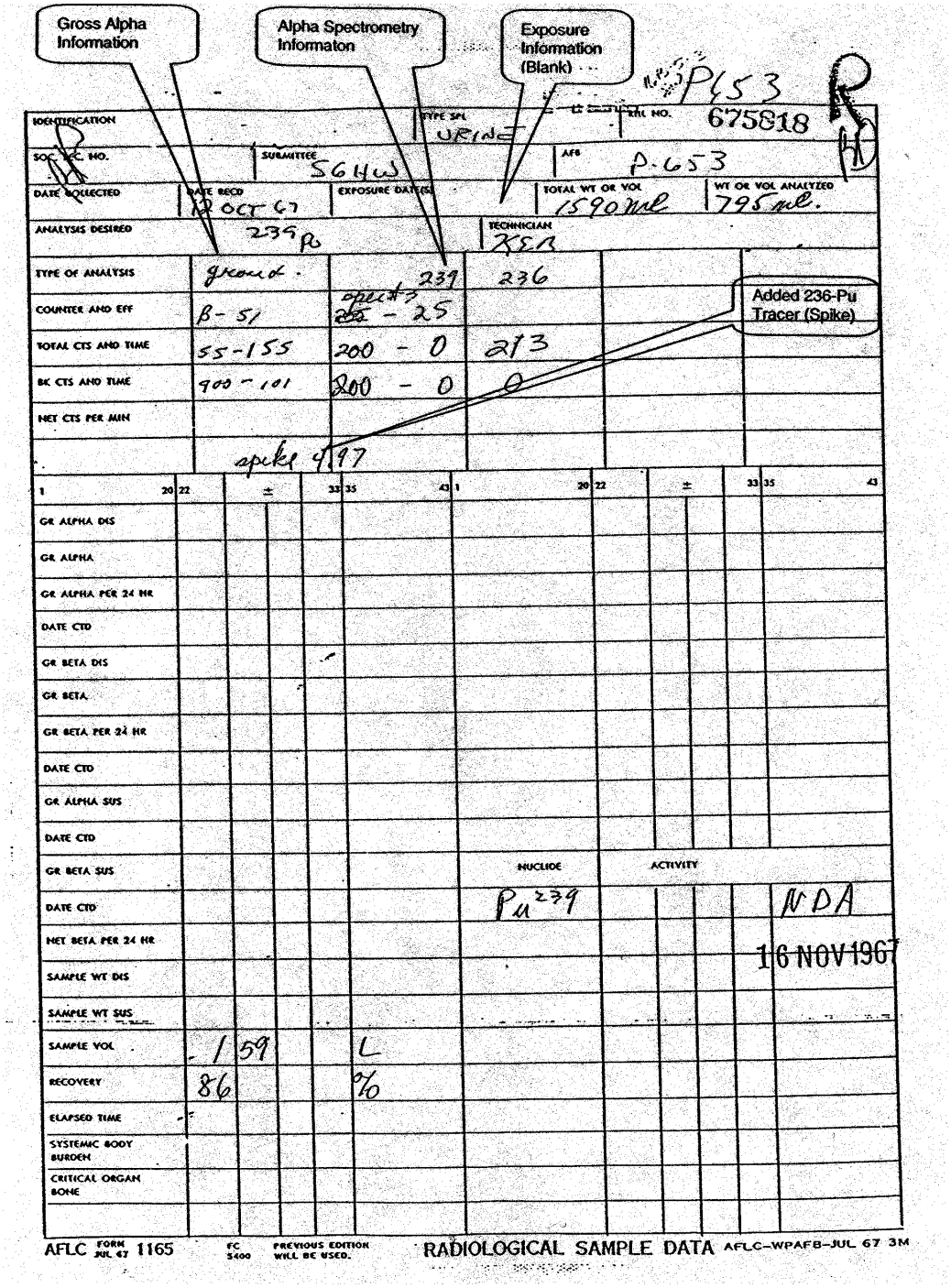

Figure B- 4. AFLC Form 1165, Radiological Sample Data (Jul 67)

counting gross alpha samples. So, the second entry (155) represents the sample counts. Similar comments apply to the background entries.

- **Alpha Spectrometry Information:** Similar information for calculating the results from the alpha spectrometry counting are included here. The counts and the counting time are interchanged as above.
- **Add ^{236}Pu Tracer (Spike):** the entry indicates the amount (in disintegrations per minute – dpm) of tracer added to the portion of the sample taken for analysis. This value is used in calculating the chemical recovery.

The preceding discussion about the forms provides the foundation for understanding the evaluation process applied to analyzing entries in the spreadsheet discussed in the next section. Clearly, consistency among the entries on the data forms and the entries in any final data set would be required. The data cards formed the only permanent record available of the actual data generated at the time of the incident. Consequently, they provided the primary means for verifying information from other sources; at least when the data on the cards were unambiguous.

B.2.1.4 Informal Data Records

An informal, handwritten record appeared in the case files of the High 26 group. That record was prepared on available paper scrap and was apparently used as source data for transfer to punched data cards. RHL used punched data cards as the primary medium for maintaining data and results for later use in organizing, sorting, reporting, and transfer to computer tape.

Figure B-5 illustrates one example of that form. The form contained an entry at the top (3826) that represents the sequential portion of the RHL assigned sample number (66-3286). The form also contains six numbered entries. The meaning of those data contained in those entries is explained in Table B-1.

Table B- 1. Data contained on informal RHL form.

No.	Meaning
1.	Urinary excretion pCi/24 hr and error
2.	Chemical Recovery (%)
3.	Total Sample Volume in Liters (L)
4.	Days elapsed from exposure to sample
5.	Day of Year Sample Completed (6256 means 256th day of 1966 or September 13, 1966
6.	Fraction of a systemic body burden

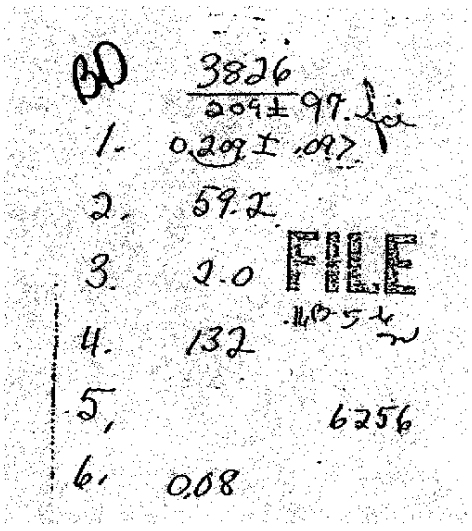

Figure B- 5. Informal RHL data form.

B.2.2. Spreadsheet

During an initial visit, IERA representatives provided a copy of a Microsoft EXCEL spreadsheet that they had prepared. The spreadsheet contained the basic data transcribed from the hardcopy data forms into the spreadsheet. Table B-2 explains the data items in the spread sheet. Figure B-6 contains an example of one page of the spreadsheet to illustrate the items of information transferred to the sheet. The individual names, Social Security Numbers, and AFSNs have been masked on this example for privacy reasons.

The spreadsheet contains information for 1,758 entries on 1,555 individuals.

Table B- 2. Data Items in IERA spreadsheet

Data Item	Meaning
Name:(Last, First, M.I)	Individual Name
SSN:	Social Security Number
AF ID # :	Air Force Service Number
Type Sample	Type of Sample – urine, nasal swipe, fecal, etc.
Type Anal.	Type of analysis performed – gross alpha, ^{239}Pu
Sample No.	Sample Number assigned by RHL
Sample Date:	Date the sample was collected.
Base:	Base of assignment of the person sampled.
Date Recived (*sic*)	Date the sample was received at RHL
Sample Volume	The total volume of the sample in Liters or milliliters
Sample Analyzed	Volume of sample used in a specific analysis procedure
Date Analyzed	The date the analysis was completed
Final Sample Result	Result in picocuries per day
Uncertainty	The counting error or uncertainty of the result (apparently 95% confidence level for gross alpha results; 68% confidence level for alpha spectrometry results.)

Although this spreadsheet does not contain any new data, it represented a substantial Air Force effort that could serve as the basis for preparing data for further evaluation and use in the dose assessment. The data added and revisions made are discussed in a later section of this appendix.

B.2.3. Reports

Additional information in the form of correspondence and written reports can provide details of the accident and the response effort, as well as insight into the approach to evaluating possible health and safety issues associated with the response effort. Several documents provided key information about those factors and formed the foundation for the pertinent analysis required of this effort. Documents that provided those kinds of key information included:

The *Palomares Summary Report* prepared by the Field Command, Defense Nuclear Agency that provides a comprehensive summary of the details of the accident, contamination levels, response efforts and limited discussions of health and safety actions (DNA 1975).

"Plutonium Deposition Registry Board, Proceedings: First Annual Meeting, 26 – 28 October 1966" prepared by the Air Force Logistics Command that described the proceedings of the first meeting of this board and reviewed key issues and discussions on the progress and future plans for the follow-up effort (Odland 1966).

Name:(Last, First, M.I)	SSN:	AF ID # :	Type Sample	Type Anal.	Sample No.	Sample Date:	Base:	Date Recived	Sample Volume	Sample Analyzed	Date Analyzed	Final Sample Result	Uncert.
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2475	n/a	Torrejon	7-Apr-66	1000	1000	N/A	0.131	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2867	Fr:845 10 Apr66 To: 650 11 Apr 66	Torrejon	22-Apr-66	1800	1800	N/A	1.10+/-0.27	n/a
Data Masked	Data Masked	Data Masked	Urine	PU	66-1193	19-Feb-66	Torrejon	3-Mar-66	1500	1000	N/A	n/a	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	66-1428	26-2-66	Moron	9-Mar-66	600	624	N/A	n/a	n/a
Data Masked	Data Masked	Data Masked	Nasal Swipe	N/A	66-2525	12-Mar-66	Torrejon	6-Apr-66	n/a	n/a	N/A	n/a	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2049	n/a	Torrejon	31-Mar-66	430	430	N/A	0.0639+/- 0.0793	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2146	19-Mar-66	Torrejon	1-Apr-66	850	850	N/A	0.179+/-0.118	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-1811	3-Feb-66	Torrejon	28-Mar-66	720	720	N/A	0.0405	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2332	19-Mar-66	Torrejon	1-Apr-66	890	890	N/A	n/a	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2866	Fr:0700 6 Apr 66	Torrejon	22-Apr-66	1100	1100	N/A	1.04+/-0.26	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	66-1403	26-Feb-66	Torrejon	9-Mar-66	660	685	N/A	n/a	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2885	Fr: 1 Apr 66 To: 2 Apr 66	Torrejon	26-Apr-66	1500	1500	N/A	0.137+/-0.107	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-1097	25-Jan-66	Wiesbaden	1-Mar-66	850	850	17-Mar-66	n/a	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2912	19-Mar-66	Torrejon	1-Apr-66	550	550	N/A	0.189+/-0.124	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	5(66-213)		Torrejon	25-Jan-66	430	200	N/A	n/a	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	23(66-231)	n/a	Torrejon	25-Jan-66	475	200	N/A	0.473+/-0.233	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	25(66-233)	n/a	Torrejon	25-Jan-66	475	200	N/A	0.473+/-0.233	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2581	23-Mar-66	Moron	11-Apr-66	1000	1000	N/A	0.0336+/- 0.0623	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	66-888	5-Feb-66	Moron	18-Feb-66	970	200	N/A	3.77+/-1.36	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	66-1402	26-Feb-66	Torrejon	9-Mar-66	1000	1000	N/A	1.04+/-1.68	n/a
Data Masked	Data Masked	Data Masked	Nasal Swipe	N/A	66-1308	n/a	Moron	9-Mar-66	n/a	n/a	N/A	n/a	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	66-496	7-Feb-66	Moron	10-Feb-66	600	200	N/A	3.89+/-1.05	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2073	19-Mar-66	Torrejon	1-Apr-66	490	490	N/A	0.141+/-0.083	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2057	9-Mar-66	Torrejon	1-Apr-66	650	650	N/A	0.0787+/- 0.0622	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2684	Fr: 27 Mar 66 To:28 Mar 66	Torrejon	12-Apr-66	1100	1100	N/A	0.+/-0.	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2498	n/a	Moron	7-Apr-66	950	950	N/A	0	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	66-1379	28-Feb-66	Torrejon	9-Mar-66	500	520	N/A	n/a	n/a
Data Masked	Data Masked	Data Masked	Urine	N/A	66-2294	20-Mar-66	Moron	1-Apr-66	950	950	N/A	0.162+/-0.136	n/a
Data Masked	Data Masked	Data Masked	Urine	Gross Alpha	66-732	9-Feb-66	Hanaw Germany	17-Feb-66	860	200	N/A	2.62+/-1.07	n/a

Figure B- 6. Example page of IERA results spreadsheet.

An article entitled "Bioassay Experiences in Support of Field Operations Associated with Widespread Dispersion of Plutonium," in *Proceedings of Symposium on Diagnosis and Treatment of Deposited Radionuclides*, sponsored by the Hanford Environmental Research Foundation (Odland 1968a).

An article entitled "Industrial Medical Experience Associated with the Palomares Nuclear Incident" published in the Journal of Occupational Medicine that was a peer-reviewed version of the previous proceedings.

A letter by Colonel Wallace, Air Force Logistics Command Surgeon, with the subject: "Palomares Broken Arrow – Report on Medical Follow-up Program" that summarized the results of the follow-up program through January 1968 and concluded that neither additional follow-up nor meetings of the Plutonium Deposition Registry Board were required (Wallace 1968).

These documents provided a narrative overview of the approach to conducting the assessment of possible exposure to plutonium at Palomares. The discussions highlighted the issues faced, the problems encountered, and the rationale that formed the basis for the effort and decisions made throughout the period of on-site activity and subsequent follow-up. These issues are discussed in Section 2 of the main report. However, key points from that review are repeated here and serve as reference for the analyses to follow. The key points include the following.

- *Sample Contamination*. During the initial phase on site, samples were collected under less than ideal conditions that could have contaminated the sample containers and samples themselves from the blowing dust containing plutonium. In fact, RHL reported frequent episodes of gross alpha contamination on the outer surfaces of the sample containers received.
- *Sample Collection Period*. Ideally, samples should be collected for a full, 24-hour period to obtain the best representation of the daily excretion required by methods for estimating body content. In fact, most of the on-site samples were limited to 12 hours because of mission needs and difficulties keeping subjects confined for an entire 24 hours. To compensate for this, RHL corrected the result for every sample with a total volume of less than 1000 milliliters to 1200 milliliters; the volume assumed to represent the daily urine output of a normal, adult male.
- *Exposure Type and Date*. Most of the response personnel spent several weeks at the site. Their activities varied from daily presence in contaminated areas to primary work in administrative areas. As a simplifying assumption, exposures were considered as single, acute intakes that occurred on the mid-point of the period of time spent on the site.

B.3. DATA EVALUATION AND PREPARATION FOR DOSE ASSESSMENT

B.3.1. Data Evaluation

One final product from this project is a dataset, containing the estimates of the possible intake of plutonium and of the associated committed effective dose equivalent that can be loaded into the Air Force Master Radiation Exposure Registry. This process requires that the data provided undergo detailed scrutiny to determine its suitability and to identify possible consistency problems. Upon receiving the collection of data forms, spreadsheet, and reports discussed above

the data review occurred in several stages. Objectives of the review included availability of data elements required for input to chosen internal dosimetry models. The primary parameters include: the type of intake (inhalation, ingestion, skin contact), the date or dates the exposure occurred, the date of collection of nasal swab or urine samples, the duration of the urine sample collection, and the results of the sample analysis. Review of the data indicated that the hardcopy forms recorded exposure date or dates, sample date, and results for many samples. In other cases, forms did not contain all the required data. Consequently, our investigators sought alternate approaches.

First, the spreadsheet and data forms were compared to determine whether all forms were present in the spreadsheet and whether the entries were correct. The initial evaluation identified a number of problems with the spreadsheet and supporting forms as shown in Table B-3.

This initial review indicated that substantial numbers of samples lacked one or more important pieces of data such as a Sample Date or Exposure Date. The review also identified 115 data forms attached to a primary card that apparently represented a repeat analysis of the same sample or a follow-up sample for an individual. Those additional samples were not in the spreadsheet.

Following the initial review additional efforts corrected many of the missing entries through more careful analysis of the information and reasonable assumptions about the missing information.

Table B- 3. Issues with Palomares Data.

Issue	Number of Entries	Percentage
Exposure Date Not Available	402	22.7
Sample Date Not Available	445	25.1
No SSN Available	385	21.8
No Air Force ID Available	2	0.11
Sample Vol. < 600 mL	323	18.3
Sample Vol. > 1000 mL	434	24.5
Number with Additional Sampling Data (2^{nd} page)	115	6.50
Number of Cards Marked Out	2	0.11
Number of Cards Not Found	5	0.28
		Total Number of Samples = 1768

The duration of sample collection is a critical piece of data that determines the daily excretion rate of plutonium in urine. Daily excretion, as mentioned above, is the accepted parameter for estimating body content at a time following exposure. Air Force reports indicated that sample collection lasted 12 hours for many samples collected at Camp Wilson. To correct, the Air Force established a procedure that corrected the result for any urine sample of less than 1200 milliliters to 1200 milliliters. Although this may have been somewhat arbitrary, it provided a reasonable and conservative correction. The procedure was deemed conservative because it would tend to overestimate urinary excretion. For example, if an individual actually collected 900 milliliters in a 24-hour period, the correction would still be applied and the estimated daily excretion would be

increased by 25%. When other factors are equal, increasing the urinary excretion also raises the estimated body content.

Our review of the data indicated that 12-hour samples were clearly designated in 42 of the samples entered in the initial spreadsheet. Attempts to duplicate the Air Force estimate of systemic body burden revealed that the sample volume correction might have been applied inconsistently. However, this did not adversely affect any conclusions about the individuals tested. This finding does not materially affect preparation of the data for this assessment except for the samples clearly identified as 12-hour samples. This review concluded that adjustments to samples that were not designated as 12-hour samples presented were unnecessary. Therefore, recorded sample volumes were assumed to represent 24-hour output unless specifically designated as 12-hour samples.

Missing or incorrect entries for Exposure and Sample Date present additional challenges to performing a reasonable estimate of radiation dose. Careful review of the data indicated that additional analysis would be required to establish these parameters.

Other observed issues included missing SSNs, AFSNs, and other entries. Upon further analysis, it became evident that the records included information on the entire spectrum of responders – from Air Force to other Services (Army, Navy, Marines); other US agencies (State Department, Bureau of Mines), possible Spanish civilian employees of Torrejon Air Base or local citizens, and at least one media representative. Only US Air Force personnel would have AFSNs, however, entries for members of the other services had similar entries. Missing SSNs introduce some problems for integrating the results into current data systems, however the issue can be resolved.

B.3.2. Preparation of Data for Analysis

The issues identified in the previous section provided the basis for an approach to refine the data by correcting errors and inconsistencies and by developing reasonable estimates of missing data. As mentioned, this process had the primary objective of developing input data for the following parameters: exposure date, sample date, sample duration, and urinary excretion rate and its estimated error. Other inconsistencies observed in the data were also corrected to the extent possible. Each of these procedures is summarized in the following sections.

B.3.2.1 Exposure Date

Exposures were assumed to be acute inhalation as discussed in the main report. The exposure date was then calculated by determining the midpoint of the time an individual spent on station. Exposure date entries on the forms included all of the following: a single date (25 Jan 66), a date range (18 Jan 66 to 30 Jan 66), an arrival date (Arr: 20 Jan 66), a month and year (Jan 66), a year (66) and a few others.

Generally, an arrival date or single date entry could be assumed to represent the beginning of exposure and that was done. The end of the exposure presented additional difficulties. For data forms that did not clearly indicate the end of the exposure period, Sample Dates for all samples for an individual were reviewed. The day before the last Sample Date was assigned as the end of exposure period. This approach seemed reasonable since the established procedure was to

collect a sample from everyone before his or her departure. In some cases, individuals may have returned to their base of assignment before providing a sample. These cases would generally represent a few days. That delay was not viewed as serious when the other difficulties and uncertainties are considered. If the last sample was collected after Camp Wilson ceased all operations on April 11, 1966, that date was used as the end of exposure.

B.3.2.2 Sample Date

Data forms did not contain Sample Date entries for 445 samples. An alternative approach was developed to provide a reasonable estimate of the Sample Date. Data on the date a sample was received at RHL and the assigned laboratory sample numbers were used to develop the estimate.

The approach compared the range of valid Sample Date entries with the Date Received at RHL and with the sequence of assigned sample numbers. Figure B-7 illustrates the distribution of the receipt of samples at the laboratory. The results of the comparison and some additional judgement allowed the Sample Date to be estimated. Although not necessarily precise, the approach allowed reasonable estimates of the Sample Date. The derived Sample Date information was then entered into a master dataset along with the other data for each urine sample. Notations documenting the source of the Sample Date were made for each entry.

B.3.2.3 Sample Duration

Actual sample duration was documented in a very small fraction (42 samples) of the samples received. Fortunately, basic sample volume data provide the basis for making any corrections needed. As discussed above, this project elected to treat recorded sample volumes as representing 24-hour outputs unless the data forms specifically designated the samples as 12-hour samples. For those, the results were adjusted to the currently accepted nominal daily urine output (1400 mL) for Reference Man. Those adjustments were performed in the intake assessment process.

B.3.2.4 Other Parameters

Analytical results for daily urinary excretion and the estimated error were transcribed as entered on the hardcopy forms. However, in the case of samples reported as No Detectable Activity, the data forms were reviewed for the presence of other calculations of a numerical result and its estimated error. When found, these actual results were used in the analysis, even when the error value exceeded the result. This procedure applied primarily when the results of multiple samples were available, as was the case for many of the "High 26" group. In these cases, although the errors were large, they nevertheless provided order of magnitude information about the levels present and were useful comparisons to other values. Specific notes are contained in the individual case files in Volumes II and III.

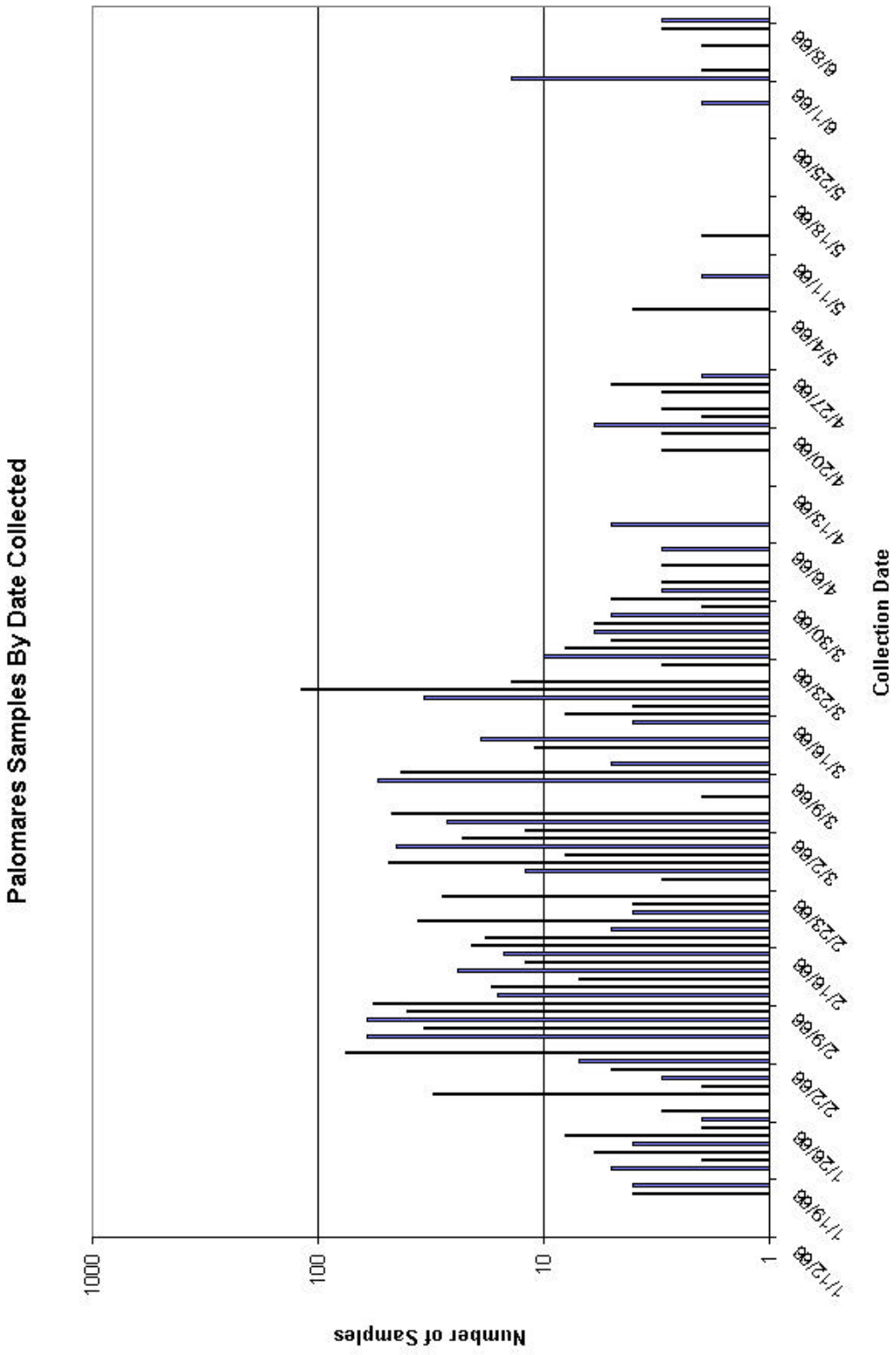

Figure B- 7. Distribution of Samples Received at RHL

B.3.2.5 Other Inconsistencies

Other inconsistencies in the dataset were also identified and corrected where possible. Although these did not affect the actual intake and dose assessments, they do affect identifying information. This review discovered inconsistencies in:

- Individual names caused by interchange of a letter or two.
- SSNs caused by typographical errors or easily identified keyboarding errors.
- Errors in designation of the analysis type, such as GrossAlpha for Gross Alpha.
- Base names caused by typing errors.

Other inconsistencies affecting only a few entries were revised as they were discovered.

B.4. SUMMARY OF THE DATA EVALUATION AND PREPARATION

After making the changes and updates discussed above the data set served as the basis for additional evaluations before processing of the intake and dose assessments. Those additional evaluations considered the amount of data available for each individual, the quality of the data, and possible issues with the data that would limit its reliability in assessing individual cases. In particular, the High 26 group had substantially more data than any other group of individuals. That group of 26 was followed-up for more than a year. Follow-up began in the summer of 1966 and continued until August and September 1967 for some of the group. Because of this, that group served as the primary group for study.

Evaluation of the data also revealed that about 115 appeared to have had their initial gross alpha analyses repeated using the alpha spectrometry technique. Or, they submitted follow-up samples upon request for analysis by alpha spectrometry. Those individuals comprised a second group that received additional evaluation of their conditions. Review of their data for reliability as indicated by adequate chemical recovery and other factors resulted in a total of 54 individuals with adequate sample data. The remaining 62 were removed because their sample results were not reported through laboratory error or other problems, or the chemical recoveries of their alpha spectrometry samples were below 40% and not considered reliable. This group was called the "Repeat Analysis" Group. Their individual cases were evaluated and the results are reported in Appendix C.2.

Of the remaining majority of samples, most represented only one sample for an individual collected while at Camp Wilson. As discussed in Appendix C.3, many of those results were quite high indicating possible contamination. Review of the data also revealed that a substantial number showed relatively low urine measurements. Their results were in the same range of urinary excretion as the individuals with the lower intakes and associated CEDEs of the High 26 and Repeat Analysis Cases. Further review of the data and assessment of a reasonable lower level of detection led to the conclusion that samples with results of less that 0.1 picocuries per day represented that reasonable lower level. Individuals with daily excretions at that level were evaluated and reported in Appendix C.3. This group, called Contamination Cutoff Cases, was not evaluated to the depth of detail as the previous cases, primarily because they had only one result for urine content. Nevertheless, the assessment provides an approximate estimate of their intake and dose.

Finally, all remaining samples were reviewed. Since their samples were collected on site and were at risk of sample contamination, the urine measurements are entered at Appendix C.4. However, no further assessment of their results was attempted.